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XXXI. *Account of several Phænomena observed during the Ingress of Venus into the Solar Disc. By the Reverend W. Hirst, F. R. S. in a Letter to the Astronomer Royal.*

Inner Temple, June 12, 1769.

DEAR SIR,

Read Nov. 16,
1769.

A GREEABLY to your desire, I now send you a particular account of all the phænomena I observed during the ingress of Venus into the solar disc ; but, before I do this, I look upon myself as obliged in gratitude to return you many thanks for the kind manner in which you accommodated me with the apparatus necessary for the observation. The telescope I used, as you well know, belonged to Mr. Dunn, and was a reflector two feet in length, and magnified 55 times. Expecting the planet to enter the solar disc at or near the zenith, I kept my eye constantly fixed at that part of the Sun a considerable time before the beginning of the transit. The first intimation which I had of the near approach of the planet, was by the sudden appearance of a violent corruscation, ebullition,

Fig. 1.

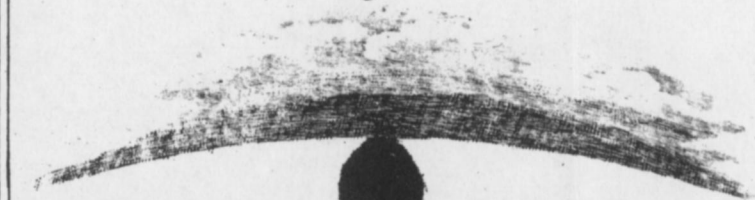
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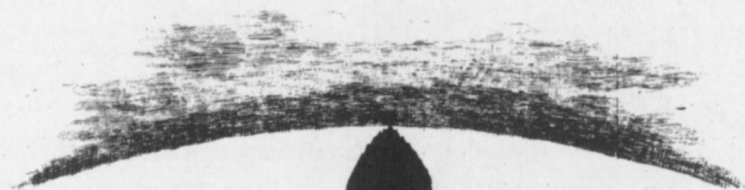
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tion, or agitation of the upper edge of the Sun, as in TAB. X. and XI. fig. 1. when I called out to my good friend, governour Vanfittart, who was so kind to give himself the trouble of taking the time for me, and desired him to take care. I had not taken this precaution above five or six seconds, when I plainly saw a black notch breaking in upon the Sun's limb, and which seemed a portion of a much less sphere than that of Venus, as in fig. 2. Instantly I desired Mr. Vanfittart, by the word *Now*, to mark the time, which was $11^h 57' 35''$ sidereal time, by Dr. Halley's little clock, belonging to the royal observatory. The last-mentioned time, allowing for the necessary corrections, and reduced to apparent time, is $7^h 11' 11''$

As I imagined, from the instructions of Dr. Halley, that the precise and accurate time of observing the internal contact is, when the thread of light should break in between the concave edge of the Sun and the convex edge of Venus, as in fig. 6. I waited till that particular period, which was when Dr. Halley's clock marked $12^h 15' 45''$, sidereal time, or $7^h 29' 18''$, apparent time, the difference being $18' 7''$ of apparent time.

The same phenomenon of a protuberance, which I observed at Madras, in 1761, *at both internal contacts, I observed again at this last transit: at both times, the protuberance of the upper edge of Venus diminished nearly to a point before the thread of light between the concave edge of the Sun, and the convex edge was perfected, when the protuberance instantaneously

* Philos. Trans. vol. LII. part i. 1761, p. 396.

broke off from the upper edge of the Sun, but Venus did not assume its circular form till it had descended into the solar disc, at least to the distance, by estimation, from the upper edge of the Sun, as described in fig. 7.

Although at the time of the contacts the atmosphere was remarkably clear, yet, as the Sun descended towards the horizon, the atmosphere grew more and more hazey, so that the edge of the Sun, as well as the edge of the Planet, began to grow more and more tremulous, and caused the Planet to assume, in appearance, different configurations, resembling sometimes a prolate and sometimes an oblate spheroid, till we lost sight of the Sun by its being intercepted by a dark cloud, or rather fog-bank, some time before the calculated time of Sun-set. Although these last phænomena are entirely optical deceptions, owing to the state of the air at that particular time, or to horizontal vapours, yet I beg it may be here very carefully remarked, that, at the times of the contacts, the air, as you can bear me witness, was perfectly clear and favourable, so that our observations were then certain, and not subjected to any fallacy in vision. The following circumstance is a proof of this assertion. The first warning which I had of the near approach of Venus to the Sun's external edge was, as I have before said, by the sudden appearance of a violent corruscation, ebullition, or agitation of the upper edge of the Sun, five or six seconds before the edge of Venus broke in upon the Sun; where alone I observed the violent agitation, the edge on each side remaining perfectly quiescent, as *a, b*, fig. 1. If this appearance had been owing to the state of *our* atmosphere only, then

then would the edge of the Sun be universally fluctuating or trembling; but as this was not the case, the undulation must be imputed to some other cause, not improbably to an atmosphere about Venus. I am the more minute on this circumstance, because you yourself, Sir, in a late * publication, have taken notice, that when I took the observation of the transit of Venus at Madras, in the year 1761, I saw *a kind of penumbra or dusky shade, which preceded the first external contact two or three seconds of time, and was so remarkable, that I was thereby assured the contact was approaching, which happened accordingly.*

Upon your foregoing paragraph I must beg leave to make the following remark, that in the transit of this present year I did not take notice of the same phænomenon as I did of the transit of Venus in India, in the year 1761; but I must here again insist upon it, that such penumbra or dusky shade I then actually saw, but I do not recollect I then saw the least undulation, ebullition, or corruscation, as happened in the transit of this present year. Yet both phænomena were conducive to the same purpose, and served to give me notice of the near approach of the planet Venus to the solar disc, the event, in both instances, justifying the presage; and both appearances might be the consequences of the same cause; which cause, as I have before observed, might be nothing less than the atmosphere of Venus. I say *might be*, for I would not be understood to assert here any

* Instructions relative to the observation of the ensuing transit of the planet Venus over the Sun's disc, on the 3d of June 1769. By the Rev. Nevil Maskelyne, Astronomer Royal, p. 32.

thing dogmatical, preserving at this time the same diffidence in expression as I made use of when I observed the transit of Venus in India, where I was apprehensive, that *to * be able to discern an atmosphere about a planet at so great a distance as Venus may be regarded as chimerical*: yet I may venture to say, that my observation of the transit of the present year seems to corroborate my assertion, in the account of the transit observed in India, in 1761; however, I shall not here peremptorily assign the cause, leaving such remarks to be made by others.

On my return from India, I was glad to find I was not particular in remarking the strange phænomenon of the oblongation of the orb of Venus at the time of both the internal contacts. It was with sensible pleasure I have seen, in the † Philosophical Transactions, that four astronomers at Upsal, in Sweden, as well as ‡ Mr. Dunn, in England, took notice of the same or similar circumstances. The appearance of this protuberance or ligament must now be universally confirmed, especially by all observers of the transit of the present year, at least by all such who have viewed it through telescopes of sufficient magnifying powers, and who have sense enough to believe their own eyes, or candour enough to embrace and acknowledge conviction, *malgré* all prejudice and preconceived opinion.

Fig. 1. represents the first presage I had of the approach of Venus to the Sun's external disc. Fig. 2. is the appearance of the black notch, when I noted

* Philos. Transf. vol. LII. part i. 1761, p. 396.

† Ibid. p. 227. and vol. LVI. 1766, p. 72.

‡ Ibid. p. 184.

the time of the first external contact. Fig. 3. is the body of the planet within the solar disc, adhering to the Sun's upper edge, the thread of light not yet formed. Fig. 4. the protuberance forming, and the undulation at, *c, d*, very violent, better seen in fig. 8. Fig. 5. the undulation decreasing, and the protuberance forming itself into a point, the luminous filaments darting between the edges of the Sun and the planet. Fig. 6. the luminous filaments cease to move, and the upper edge of the planet is well defined. Its whole orb more opaque, but not yet divested of its oval appearance, the thread of light at *c, d*, is formed; and at this period I marked down the time of the internal contact. Fig. 7. the planet is restored to its circular figure.

I shall conclude this account with a few remarks I think it necessary to make on the manner in which my observation of the transit in India, in 1761, was inserted in the Philosophical Transactions. I am very much grieved, that the observations of the equal altitudes and meridional transits for regulating my time-keeper were altogether omitted. Had this not been the case, every one might have judged of the care and pains I took in that distant part of the world, as well in making several of my instruments myself, as in using them when made. What degree of confidence was to be given to my observations might be easily seen. Monsieur Pingré.* would have had no occasion to lament that I did not acquaint *the world in what manner I observed the equal altitudes to determine the passage either of a fixed star, or of the Sun over the*

*. Philos. Transf. vol. LIV.. 1764, p. 156.

meridian, &c. If these particulars had been inserted, there would have been no occasion likewise to alter my numbers respecting the periods of the transit, since every astronomer, from the previous observations, might draw his own conclusions. Observations ought not to be rejected or stifled because they do not entirely suit any adopted system, or favourite parallaxic angle. If I declared I saw an oblongation of the planet Venus, it ought not to be discredited because another did not see it. If I gave reasons for suggesting that Venus had an atmosphere, but had not a satellite, the report should have been impartially stated, though another should be of a contrary opinion.

I shall beg leave to extract the following paragraph from my original letter from India to Lord Macclesfield, on the subject of the transit of Venus, in the year 1761, which, for what good reason I know not, was suppressed, and had not the honour of a place in the Philosophical Transactions; but which I am the more desirous should now be inserted, as it tends to elucidate a matter of fact, and to render indisputable an astronomical truth, only to be established by those who had the opportunity of seeing as I did, the entire passage of Venus over the solar disc. The paragraph is as follows:

“ Looking over the Philosophical Transactions,
 “ some time before the transit, I found Mr. Short
 “ had observed a small star near Venus, which had
 “ the same phasis as that planet. This gave suspicion
 “ that Venus was attended with a satellite. A cor-
 “ roborating circumstance was added, *viz*, M. Cas-
 “ sini, in his *Elements d’Astronomie*, mentions a like
 “ observation. This I regarded as a favourable
 “ opportunity,

“ opportunity, concluding, that if Venus had a fatel-
 “ lite, it must be seen at its transit over the Sun’s disc ;
 “ accordingly, I gave notice of this to Captain Barker,
 “ of the Company’s Artillery” (now Colonel Sir Ro-
 bert Barker), “ who took the observation at Pondi-
 “ chery. I also mentioned it to the Jesuits, who
 “ observed at the Great Mount, about $7\frac{1}{2}$ miles S.
 “ 50° W. of Madras, but neither of them saw any
 “ appearance in the least like a satellite. I also spoke
 “ of it to Governour Pigot” (now Lord Pigot) “ and
 “ Mr. Call, who with myself saw not the least speck
 “ attending that planet; whence we may now ven-
 “ ture to affirm, *That Venus has not a Satellite.*”

I am,

with great respect,

DEAR SIR,

Your affectionate, humble servant,

W. Hirst.